Appendix 2. Assessment Summary

Several population models were used to assess the status of red snapper: VPA, ASAP, CATCHEM and SRA. The ASAP model had been used in the most recent assessment (Schirripa and Legault 1999), but exhibited instability when used to address the very long time series (1872-2003) and to a lesser extent with the shorter time series (1962-2003 and 1984-2003). Modifications to the ASAP code have reduced, but not eliminated that instability. The newly developed program CATCHEM was created to be able to model fish discarded due to a minimum size internally as opposed to the external manner in which discard estimates have been made in past red snapper assessments (as part of the probabilistic aging procedure). CATCHEM also can be used to simultaneously model multiple fleets (which VPA cannot do, but ASAP can) and multiple stocks with possible mixing (which ASAP cannot do). CATCHEM was used in this assessment primarily to explore the long time series (1872-2003), but the shorter time series were also examined. The use of VPA was recommended at the August assessment workshop to examine vulnerability patterns. (It is worth noting that two different VPA programs were employed at the August meeting and some differences were observed in the results. Since then it has been determined that those differences were generally due to differences in input parameters). The simplicity of the VPA model permitted its use in examining the potential effects of multiple assumptions including: different stock structure assumptions (one Gulf wide stock or separate eastern and western stocks), different natural mortality rates on the youngest ages and the impacts of different ages at recruitment. The SRA model also was generally used for guidance on the effects of data and model assumptions rather than to develop management advice. Results from the SRA model are presented in the file Appendix 3 Table Summarizing All Models, however they are conditioned on some earlier (November) results from other models which have since been updated.

CATCHEM was selected in place of ASAP as the primary model by the AW. CATCHEM is in many ways a generalization of the ASAP approach, with more flexibility and the ability to model geographic substructure. One of the more important differences between the two models lies in the way the age structure of the population in the first year is estimated. The initial age structure is modeled in ASAP as deviations from the equilibrium age structure expected under virgin conditions, in which case the estimated deviations and virgin status will be correlated. If there is little information in the data concerning the initial conditions, the starting age structure will be forced to resemble the virgin condition even if the population has been heavily exploited. On the other hand, if there is some information on the initial age structure in the data, then this construct will cause the model to adjust both the deviations and the virgin condition, possibly biasing subsequent MSY benchmarks. This is especially problematic for the 1962-2003 ASAP runs, which substitute an ‘average’ age composition in place of the missing values for earlier years. In the CATCHEM model the initial age structure is set to virgin levels for the 1872-2003 series, but estimated independent of the virgin condition for the shorter time series. The latter is accomplished by estimating a ‘prehistoric’ recruitment level and utilizing an input relative effort series to compute the fishing mortality rate on those ‘prehistoric’ cohorts until the first year of data. If recruitment varies strongly over the 30 year prehistoric period or the input effort series trends are grossly in error, then the initial conditions established by CATCHEM for the shorter time series may be biased.

Another important difference between the two models is the first age class, which is age 0 in ASAP and age 1 in CATCHEM. Both models assume a Beverton and Holt spawner recruit relationship, therefore starting with age 0 implies all of the density dependent effects occur very early in the life history of the animal and subsequent mortality occurs because of shrimp bycatch and density independent natural causes (M_0=0.98yr^{-1}). Starting with age 1, on the other hand, implies that the density dependent processes dominate mortality over the first year of life such that shrimp bycatch of age 0 fish can be ignored. Stock reduction analyses on similar data suggest that stock appraisals become less optimistic as density dependence extends to older ages, which consistent with the difference between ASAP and CATCHEM (the VPA results, however, suggest the opposite is true). To date these differences have not yet been explored in either CATCHEM or ASAP.

Other differences between ASAP and CATCHEM exist, but are probably less important. They include:

(1) the use by ASAP of age composition data derived from length by use of the Goodyear (1997) procedure (see Turner et al. 2004), which is quite different from the observed age composition data discussed by Nowlis (2004).
(2) different indices of abundance
(3) the use by CATCHEM of data on offshore shrimp trawl effort from 1962-2003 (see Porch and Turner 2004)
(4) the use by ASAP of a manufactured (not observed) time series of shrimp bycatches from 1962-1972 (see Porch and Turner 2004)
(5) Discarded fish are modeled internally by CATCHEM, rather than read as inputs in ASAP
(6) CATCHEM models the east and west populations simultaneously, i.e., in a single run. The MSY benchmarks in CATCHEM maximize the Gulf-wide long-term yield and assume that the proportional change in effort will be the same for the eastern and western fleets, which implies that the east and west will be managed as a single unit (as they are presently). In contrast, ASAP models the east and west populations one at a time, i.e., in two separate runs. The MSY benchmarks in ASAP therefore maximize the long-term yields of east and west independently with no linkage between the effort exerted by the respective fleets, which implies that the east and west will be managed separately with their own MSY targets.

After the December Assessment workshop the probabilistic age composition was recalculated and all CATCHEM, ASAP and VPA analyses were re-run. The recalculation of the age composition corrected the recreational minimum size for 2000-2003 from 15" to 16". The ASAP runs incorporated that change and were made with a modification to the program that allowed the plus-group to deviate from virgin conditions, thereby reducing some, but not all of the instability previously observed in the runs with the short time series; an average age composition was still needed for years when no age composition was available but catches were recorded.

Summary of estimated stock status from all model runs
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Overall, several general patterns can be detected in the summary plots. First, it is important to note that the perceptions of stock status depend on the way the MSY-related benchmarks are defined. In general, the perceptions were far more optimistic when the MSY benchmarks were conditioned on the current level of shrimp bycatch ("current shrimp" scenario) than when the MSY benchmarks were conditioned on zero shrimp bycatch ("no shrimp" scenario) or conditioned on reductions in bycatch effort that are commensurate with the reductions in directed effort (the "linked" scenario). The term "optimistic" is relative, however, because more than half of the "current shrimp" model runs still identify the stock as overfished and many of those also suggest that overfishing is occurring. Nearly all models showed a greater proportional change in the relative biomass indicator (towards less overfished) than in the relative F indicator (towards less overfishing) when the MSY definition was changed from linked to conditional on current shrimp bycatch.

Two other factors that seem to explain much of the spread in the results are steepness and the length of the time series of data (particularly the use of the ultra-historical landings information, i.e., the 1872-2003 series). In the case of the ASAP assessment model framework, steepness was considered difficult to estimate and was therefore fixed at three values: 0.81, 0.90, and 0.95. In the Gulfwide and Western model runs, the status plots show that the point for steepness = 0.81 is the least overfished (relatively speaking) with the least amount of overfishing occurring, and the status for higher steepness values veer diagonally up and to the left from steepness = 0.81 (i.e., more overfished and greater overfishing) (Figs 1,2,5,6). In the Eastern model runs, the pattern is reversed for the low M cases (steepness=0.95 is the least overfished); in the high M cases the intermediate steepness (h=0.90) is the least overfished, although the value is similar to h=0.81 (Figs 3,4). In the case of the CATCHEM framework, the results with the shorter time series were also sensitive to the level of steepness, but the opposite trend was observed in that the stocks were estimated to be in even worse (perhaps unrealistically worse) shape with lower steepness. It must be reiterated, however, that all of the CATCHEM runs began with age 1, whereas all of the ASAP runs began with age 0. Moreover, the solution surface with the shorter time series was not well-behaved and both the ASAP and CATCHEM models had difficulty navigating it. Both found local minima with similar objective function values, but very different implications. Hence, one should be careful not to over-interpret the results based on the shorter time series. The CATCHEM runs with the longer time series were much less sensitive to the value of steepness. Although the model estimated steepness to lie near the imposed upper limit of 0.97, the perception of stock status was almost unchanged when steepness was fixed to 0.81.

It was also noted by the AW that the CATCHEM estimates of virgin recruitment (R_0) and MSY obtained with the shorter (1962 and 1984) time series were several times greater than those obtained with the longer time series, which some have interpreted as suggesting an increase in the productivity of the stock over the last few decades. An alternative interpretation is that the lack of contrast in the shorter time series is responsible for the larger R_0 estimate. At this time, neither interpretation can be ruled out.

The assumed magnitude of the natural mortality rate on age 1 seems to have had a relatively minor impact on most of the appraisals of stock status. Generally the low M ASAP and CATCHEM models estimated a slightly less overfished stock with perhaps less overfishing as compared to the high M runs. Interestingly, the opposite appeared to be true for the VPA runs; going from a high M to a low M model led to a more overfished status with greater overfishing.

In the VPA runs (which used only the shortest time series, 1984-2003, computed only the linked MSY scenario, and indicated steepness was ~1), the main sources of variability in estimated stock status were the assumed age of recruitment (either 0 or 1) and whether R0 was estimated or fixed to a level that corresponds to 8.5 times the three year average low for the time series (1984-2003). In models with recruitment at age 1, the stock is almost always estimated to be less overfished than indicated by the corresponding models with recruitment at age 0. When R0 is fixed, it sets the virgin benchmark higher, and the stock is estimated to be more overfished.

For the 1962 and 1984 time series, the ASAP models which are most comparable with CATCHEM are the east and west runs with high M and steepness of 0.81 and 0.95. The models were mostly in agreement on overfishing and overfished status, although CATCHEM was always more overfished than ASAP outcomes. This could be due to the assumed age of recruitment (CATCHEM assumes age 1 while ASAP assumes age 0), as the SRA results suggest, however it is the opposite of the pattern observed for the VPA (which found that age 1 recruitment models were less overfished than age 0 recruitment models). For the 1984 time series, the VPA models with recruitment at age 1 and the linked MSY benchmark scenario are most comparable with CATCHEM as far as model assumptions, although structurally the two models are very different. Of the four models that might be compared, three of the VPA runs estimate the stock to be either not overfished or not undergoing overfishing.

All CATCHEM models estimated the stock to be overfished with overfishing occurring, whereas several VPA and ASAP models estimated the stock to be in fine shape (not overfished and/or no overfishing). As noted previously, the more optimistic ASAP runs resulted from the “current shrimp” scenario and usually assumed lower steepness values. However, in the west ASAP model runs, even the high steepness estimated no overfishing for the “current shrimp” scenario. A possible reason why this differs from CATCHEM is that ASAP, by including age 0, gives added importance to the shrimp bycatch relative to the directed fleet. Therefore, when the MSY benchmark is conditioned on current shrimp bycatch levels, the remaining directed fishing mortality is estimated to be just a fraction of Fmsy.

Key for model abbreviations in Figure Legends

A=ASAP
V=VPA
C=CATCHEM
L=Linked
c-s=current shrimp
n-s=no shrimp (CATCHEM only)
M=high mortality
m=low mortality

81,90,95,97 are steepness values
r=estimated recruitment (VPA)
R=fixed recruitment 8.5X (VPA)
0=age 0 recruitment (VPA)
1=age 1 recruitment (VPA)

_62, _84 are time series (VPA and ASAP)
1872, 1962, 1984 are time series (CATCHEM)

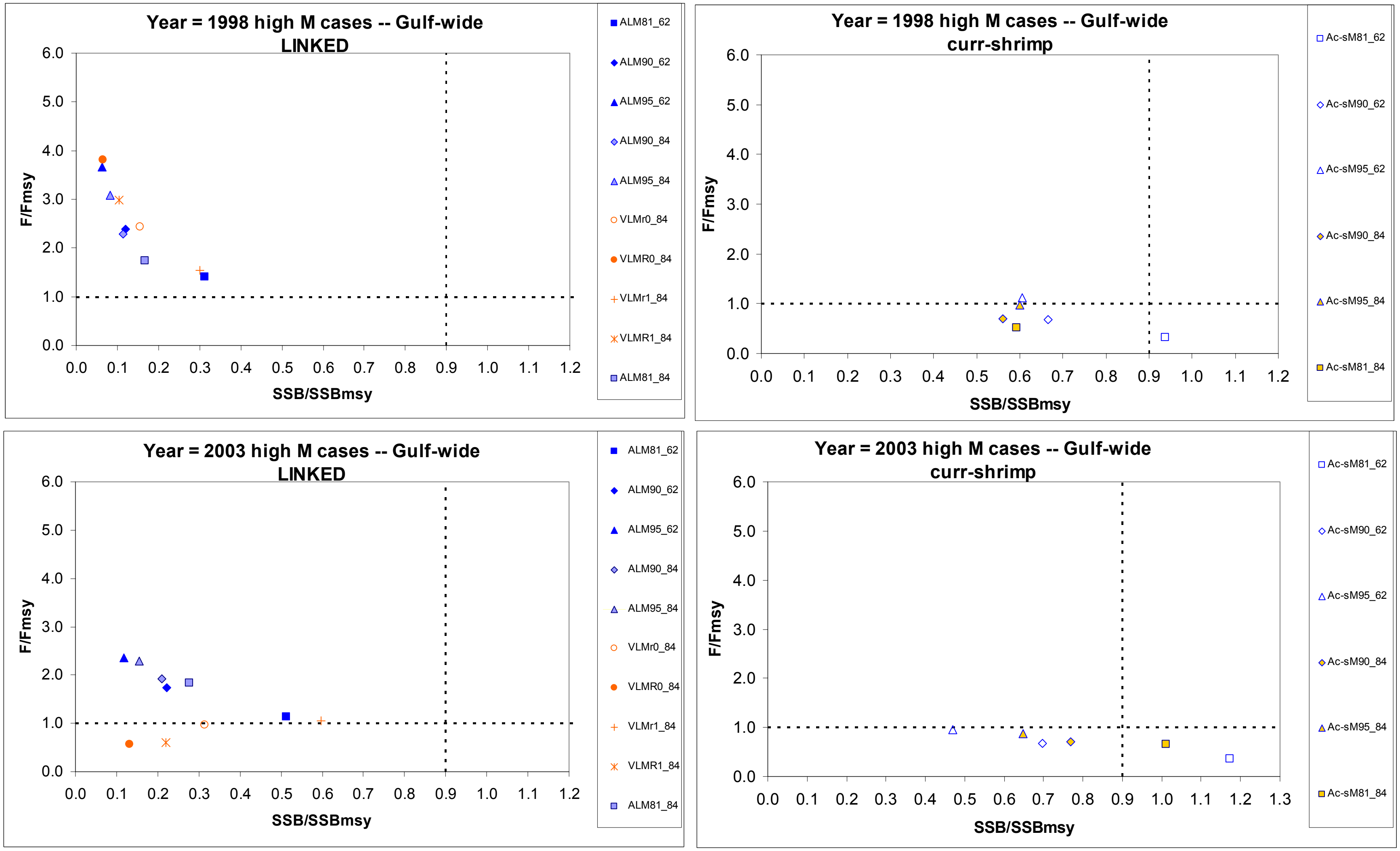


Figure 1. Gulfwide models of stock status with high natural mortality (M_0=0.98, M_1=0.59, M_{2+}=0.1).

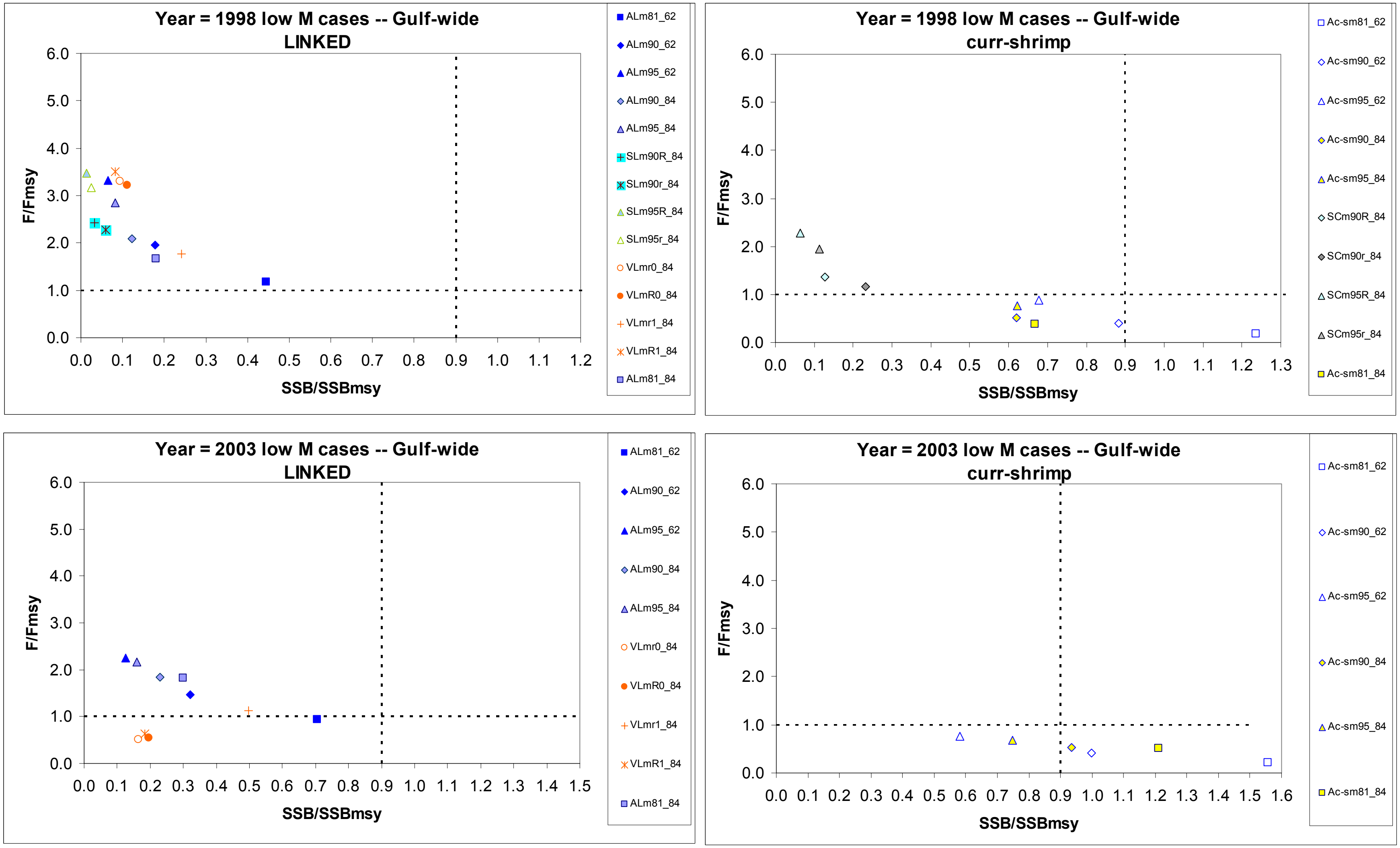


Figure 2. Gulfwide models of stock status with low natural mortality (M_0=0.48, M_1=0.29, M_{2+}=0.1).

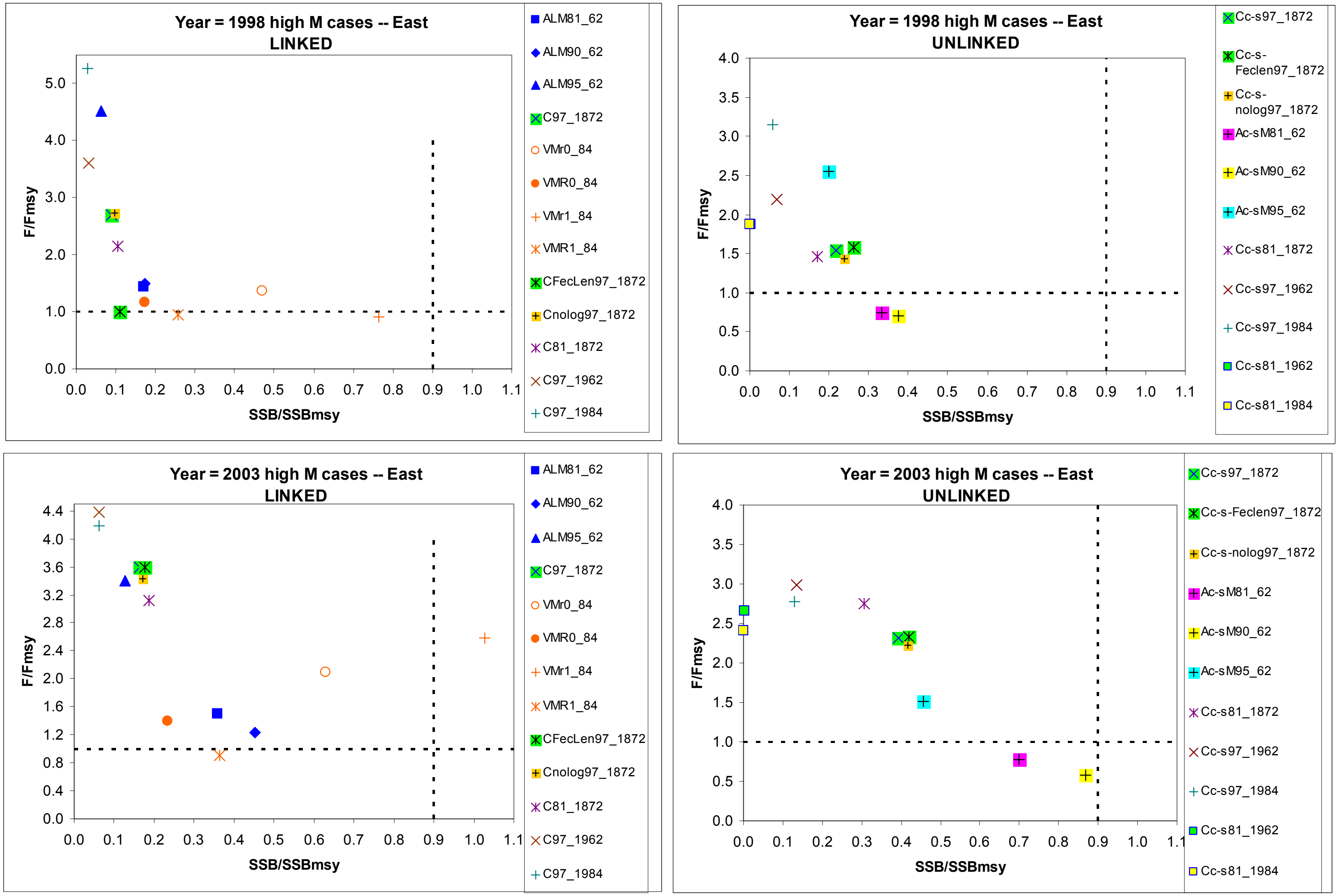
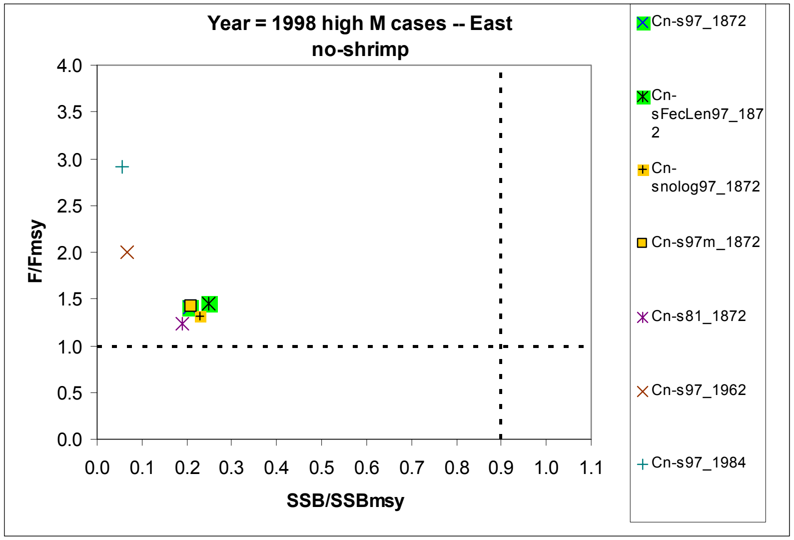


Figure 3. East models of stock status with high natural mortality (M_0=0.98, M_1=0.59, M_{2+}=0.1).



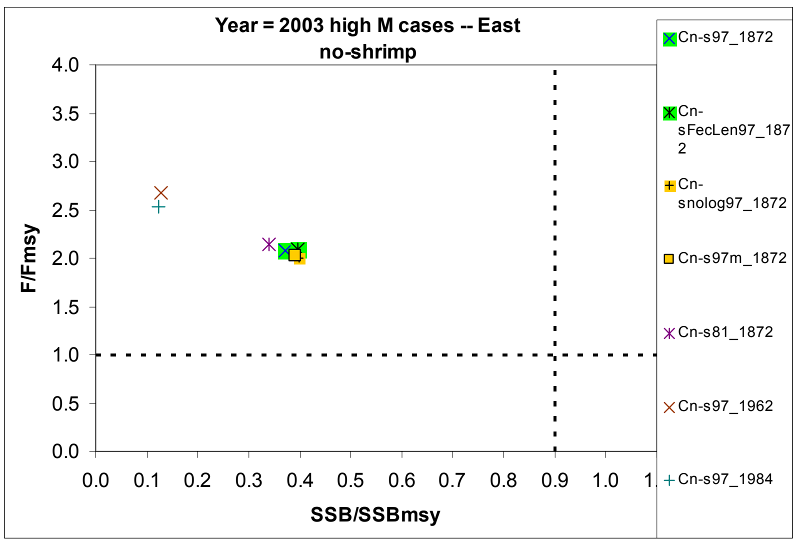


Figure 3. (cont.)

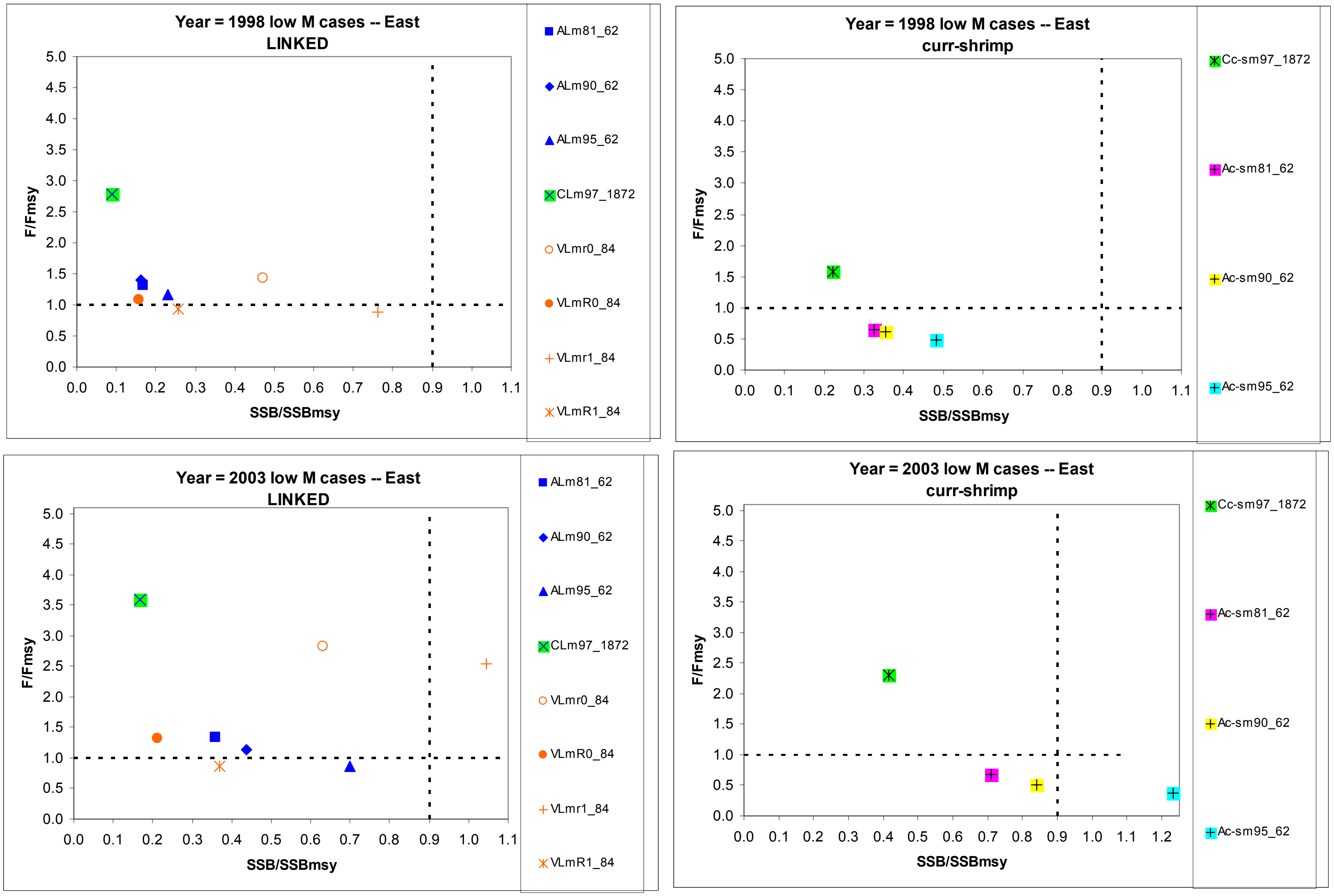


Figure 4. East models of stock status with low natural mortality (M_0=0.48, M_1=0.29, M_{2+}=0.1).

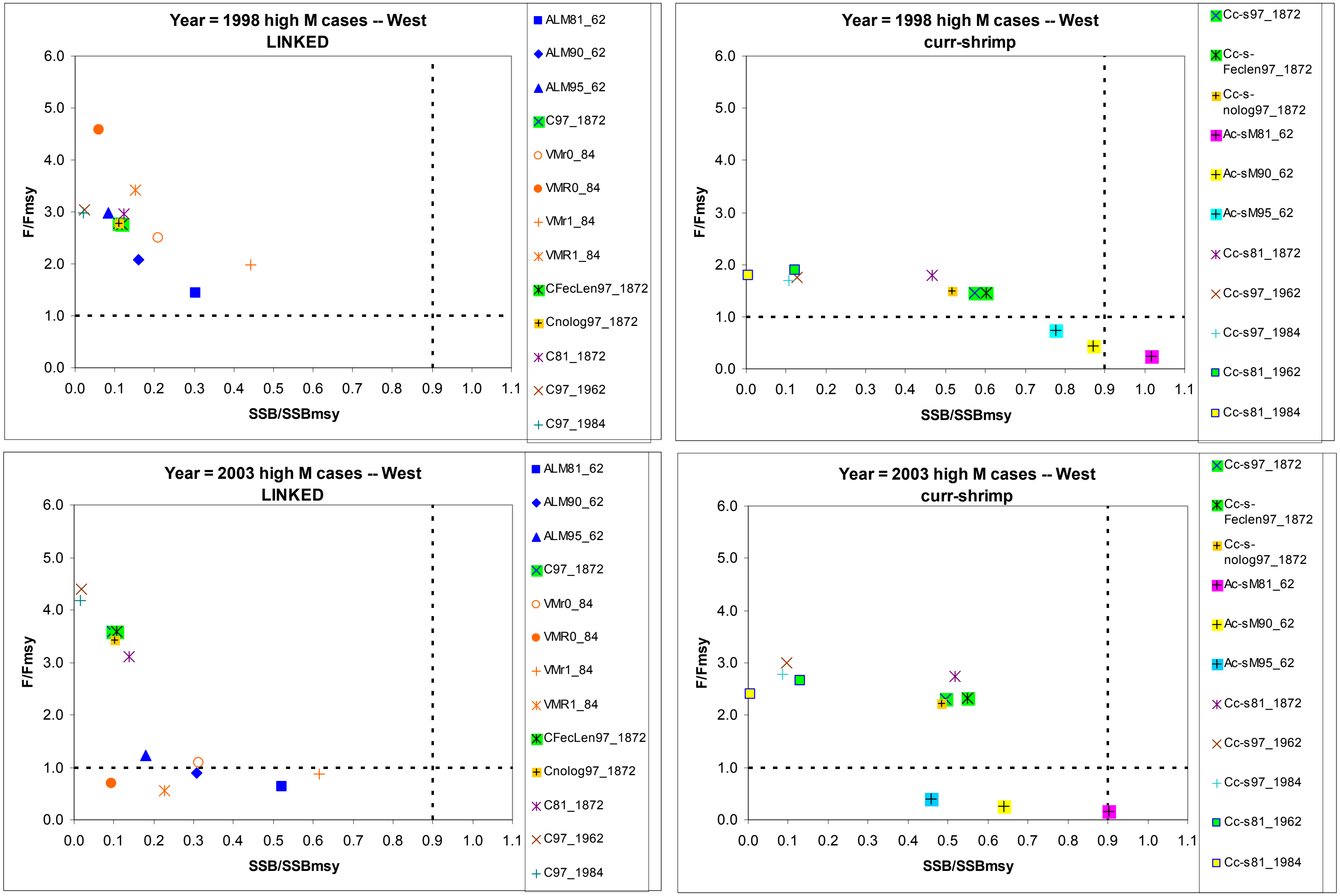
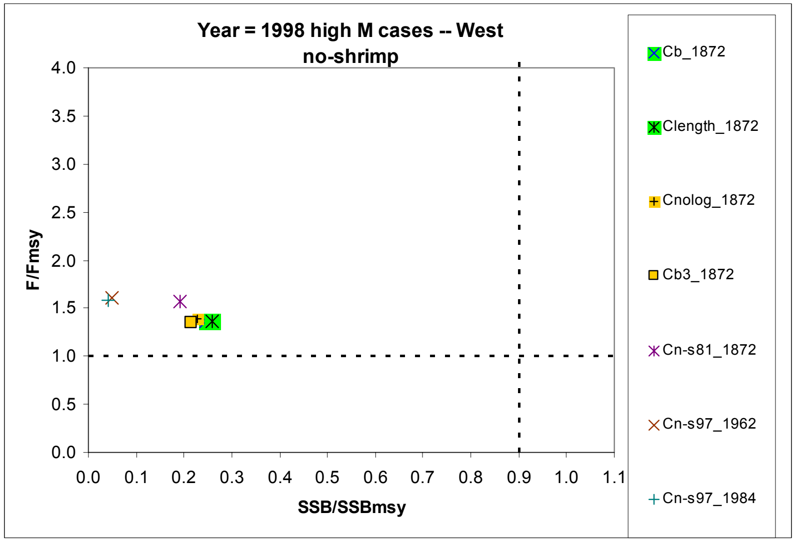


Figure 5. West models of stock status with high natural mortality (M_0=0.98, M_1=0.59, M_{2+}=0.1).



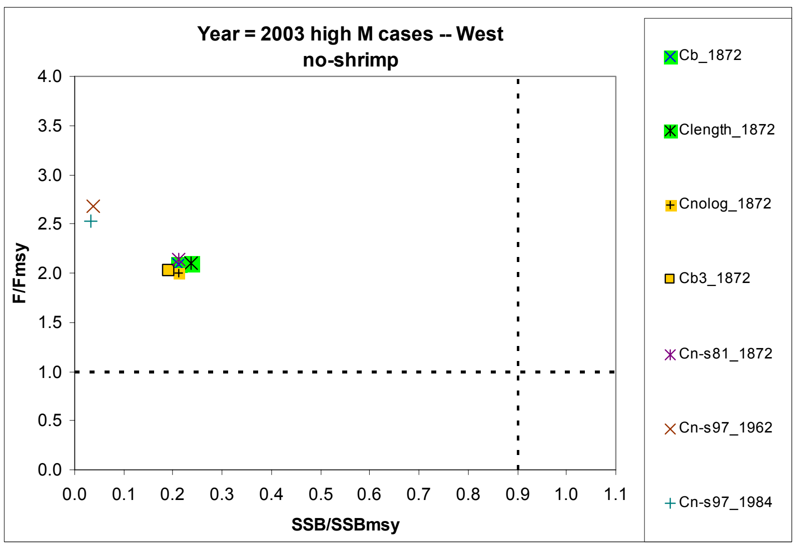


Figure 5. (cont.)

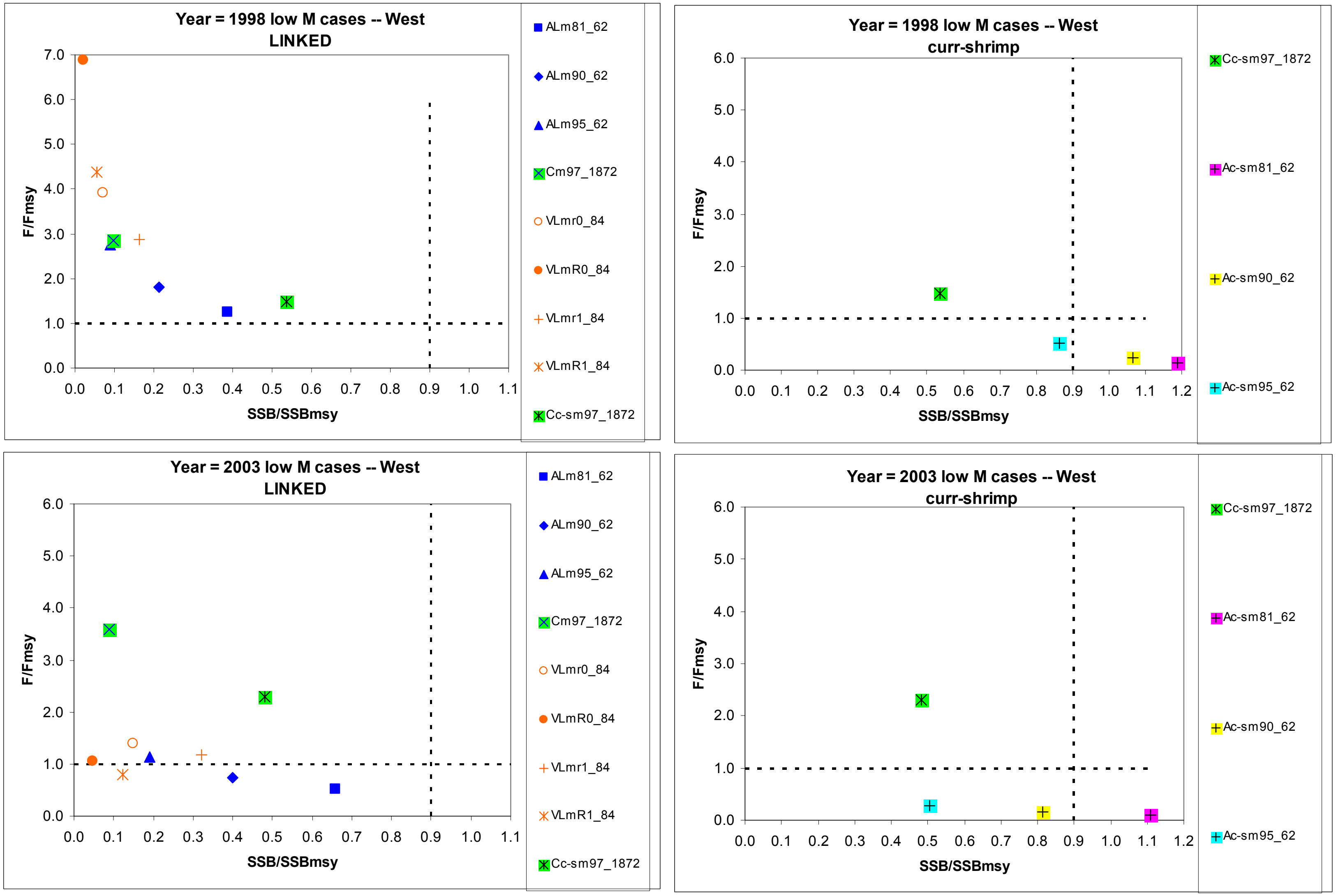


Figure 6. West models of stock status with low natural mortality (M_0=0.48, M_1=0.29, M_{2+}=0.1).